

CNLS & Information Theory, Computer Science, Statistical Physics

• Conferences & Workshops Series

[illegible]

Center for Nonlinear Studies

Algorithms, Inference, & Statistical Physics

May 1-4, 2007 | Bishop's Lodge, Santa Fe, NM

<http://cnls.lanl.gov/AISP>
AISP@cnls.lanl.gov

The intersection of computer science, information theory, and statistical physics has seen a recent explosion of activity, resulting in new algorithms and new methods of analysis. Diverse computational challenges including constraint satisfaction, error correction, and control of massive networks have benefited from techniques and insights offered by statistical physics. Physics, at the same time, has been significantly diversified by approaches from discrete computation, such as message-passing algorithms.

Topics:

- * New approaches to information transmission
- * Graphical models & predictive inference
- * Finite-length scaling in error-correcting codes
- * Distributed source coding
- * Average-case and predictive complexity
- * Message-passing algorithms
- * Replica symmetry
- * Ad hoc networks
- * Genetic Coding
- * Multi-objective optimization

Confirmed Speakers:

Dimitris Achlioptas
UC Santa Cruz

Vladimir Chernyak
Pewee State

Ashish Goel
Stanford

Matthew Hastings
LANL

Bhaskar Krishnamachari
UCSD

Muriel Médard
MIT

Marc Mézard
ENS Paris-Sud

Andrea Montanari
Stanford

Christopher Moore
Rutgers & Santa Fe Inst.

Muthu Muthukrishnan
IBM

Devavrat Shah
MIT

Sakhar Tatikonda
Stanford

David Tse
UC Berkeley

Ruediger Urbanke
EPFL

Yael Weiss
The Hebrew Univ.

Martin Wainwright
UC Berkeley

Jonathan Yedidia
MIT, Research Lab


Organizing Committee:
Misha Chertkov,
Anders Hanson,
& Alton Percus
(Los Alamos National Lab)

For more information or to register for the conference,
please visit our website or email us.


Los Alamos
NATIONAL
LABORATORY


CMU Center for
Nonlinear Studies


This event is
Open to the Public



Center for Nonlinear Studies







Classical and Quantum Information Theory

March 24-28, 2008 | Santa Fe, NM, USA

Register online at:
<http://cnls.lanl.gov/CQIT>
[cgit@cnls.lanl.gov](http://cnls.lanl.gov)

Conference Information:

Over half a century ago, it was realized that quantum and statistical field theories are intimately related, both at the formal and physical levels. Quantum critical phenomena provide examples where quantum systems are frequently mapped onto classical systems, while non-equilibrium statistical mechanics provides an example of proceeding in the other direction via stochastic operator techniques. We are now witnessing a similar phenomenon in the areas of classical and quantum information theory, where methods or concepts of many-body physics are found to be the common element for seemingly different problems such as quantum and classical spin glasses and quantum and classical error correcting codes.

Our workshop will explore and exploit these developments, inviting leading experts to discuss the latest problems and techniques of interest. We intend to explore various questions at the interface of these fields such as, to name a very few, possible new behaviors in quantum spin glasses due to entanglement and the role of message passing algorithms for quantum systems, both for decoding of error correcting codes and for finding ground and thermal states.


This conference will bring together experts from classical and quantum information theory, statistical physics and computer science, in order to improve communication and contribute to a coherent description of this class of problems.

Call for Contributions:

If you are interested in presenting a contributed talk or poster, please submit an abstract online by March 3, 2008.


Speakers:

Dorit Aharonov
 Andrei Andreianov
 Alessio Ambrogi
 Howard Alderson
 Sergei Belyi
 Valery Boyko
 Sergey Bravyi
 Scott Brown
 Jens Eisert
 Paul Fermi
 Michael Freedman
 Leonid Gurvits
 Jim Harrington
 Aram Harrow
 Boris Hout
 Patrick Hayden
 Hailu Huang
 Vladimir Korshun
 Leonid Levitov
 Brad Marston
 Andrea Montanari
 Chris Moore
 Yuhua Qian
 Nikolai Reshetkin
 David Rosenberg
 John Preskill
 Eric Riedel
 David Shor
 David Sherrington
 Shihui Shouh
 Barbara Teresi
 Frank Verstraete
 Paul Wernick
 Pawel Wołosz
 Jonathan Yeatman
 Oleg Zaboronnikov
 Wojciech Zurek



This conference is
Open to the public

Conference Location:
 La Posada de Santa Fe



Conference Organizers:
 Misha Chertkov
 Matthew Hastings
 Razvan Teodorescu
 John Yard

Technical Program Coordinator:
 Hasan Guclu

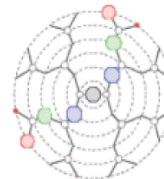
Conference Administrator:
 Adam Shipman

WORKSHOP INFO	REGISTER	AGENDA	CNLS	LANL
-------------------------------	--------------------------	------------------------	----------------------	----------------------

Applications of Statistical Physics to Coding Theory

Santa Fe, New Mexico
Jan 10 — Jan 12, 2005

Organizing committee: M. Chertkov (T-13), I. Gabitov (T-7 & UA, Tucson), B. Vasic (UA, Tucson)



Operated by Los Alamos National Security, LLC for NNSA

UNCLASSIFIED

LA-UR 09-05472





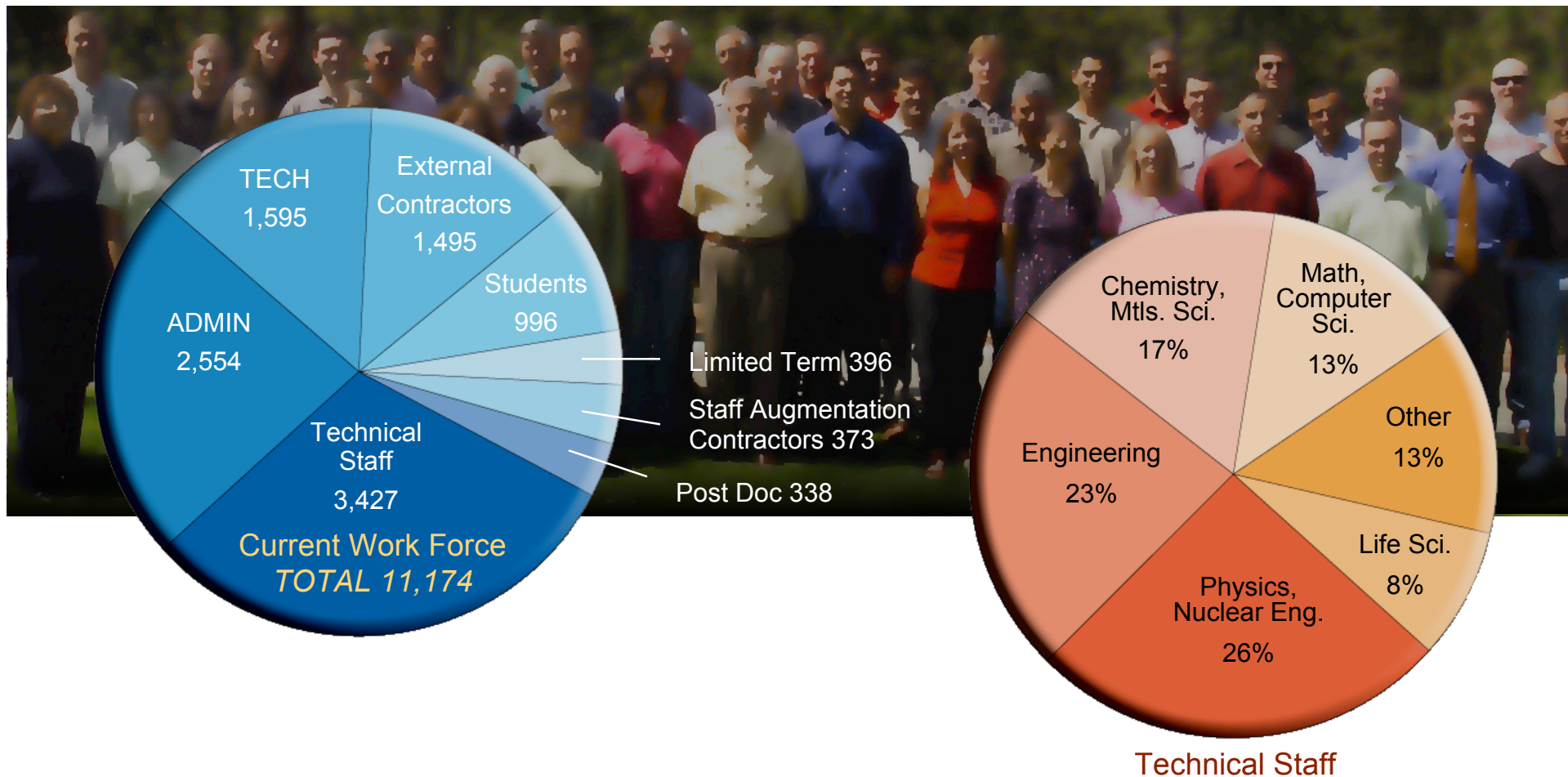
Los Alamos National Laboratory

a unique, irreplaceable national resource in the Department of Energy

Los Alamos National Laboratory

- Is vital to the U.S.
- Is the most diverse scientific institution in the world
- Solves complex challenges that change society
- Develops revolutionary advances from national security to biomedical to climate and energy



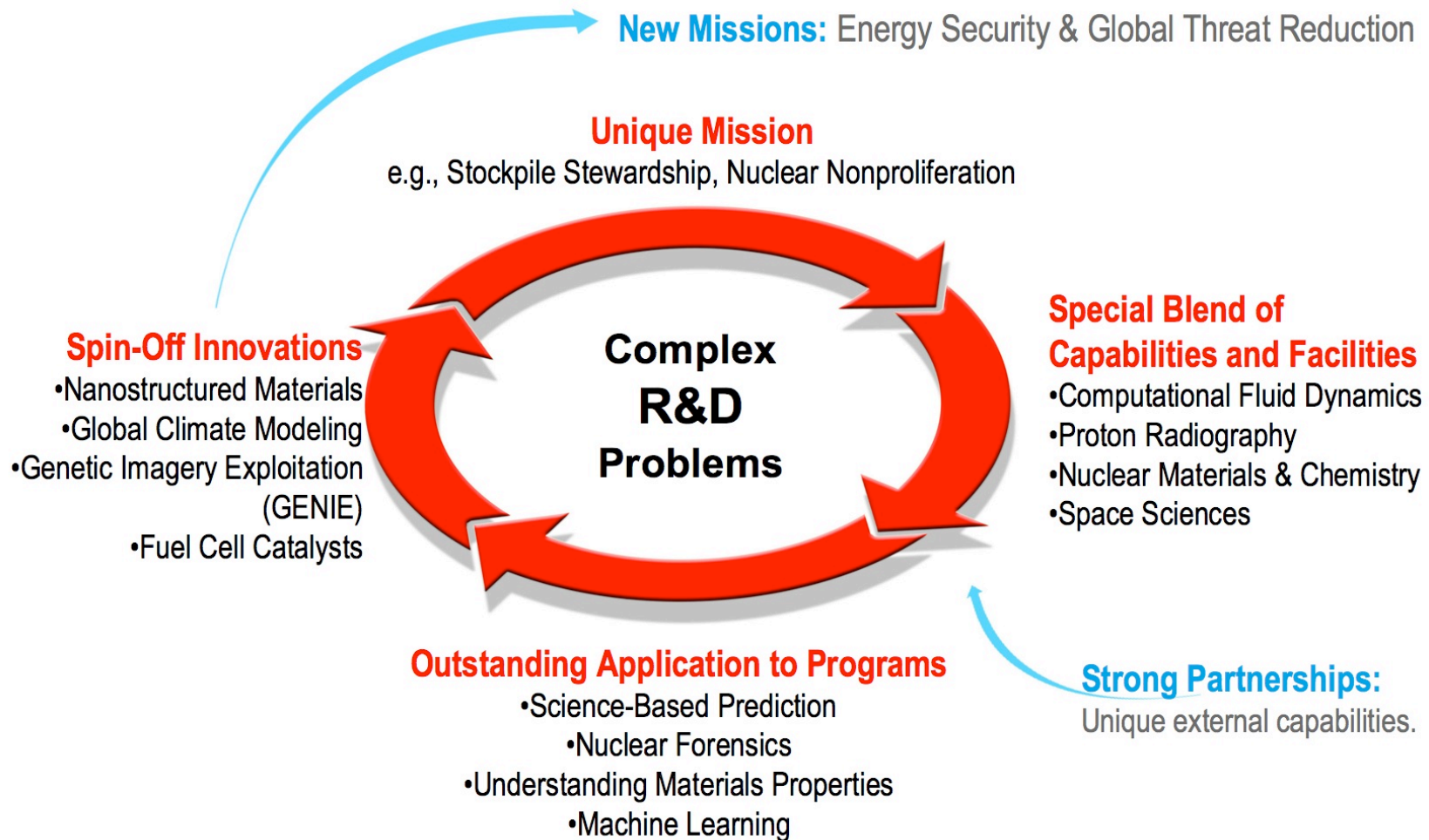


Technical Staff

LANL S&T base is Broad and Deep

- Drawn from across the nation
- 2,130 PhDs
- One quarter of workforce started as students or postdocs

Integrating capabilities, enables spin off innovations to tackle new challenges



National Security Science Laboratory: S,T&E Focus

Los Alamos is a material centric laboratory with unsurpassed nuclear and theory, modeling, and high-performance computing expertise and capabilities.

Forensic Science for Nuclear, Biological & Chemical Threats

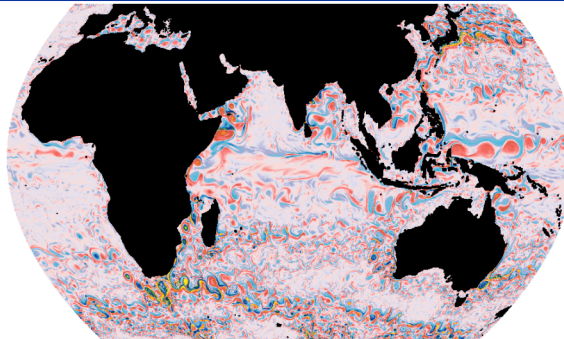
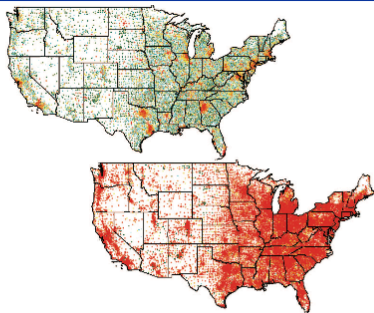
- Stewardship
- Weapons of Mass Destruction
- Energy

Information Science & Technology

- Stewardship
- Data Sciences
- Intel
- Basic Science

Materials for the Future

- Detectors & Sensors
- Energy Science
- Materials for the Stockpile



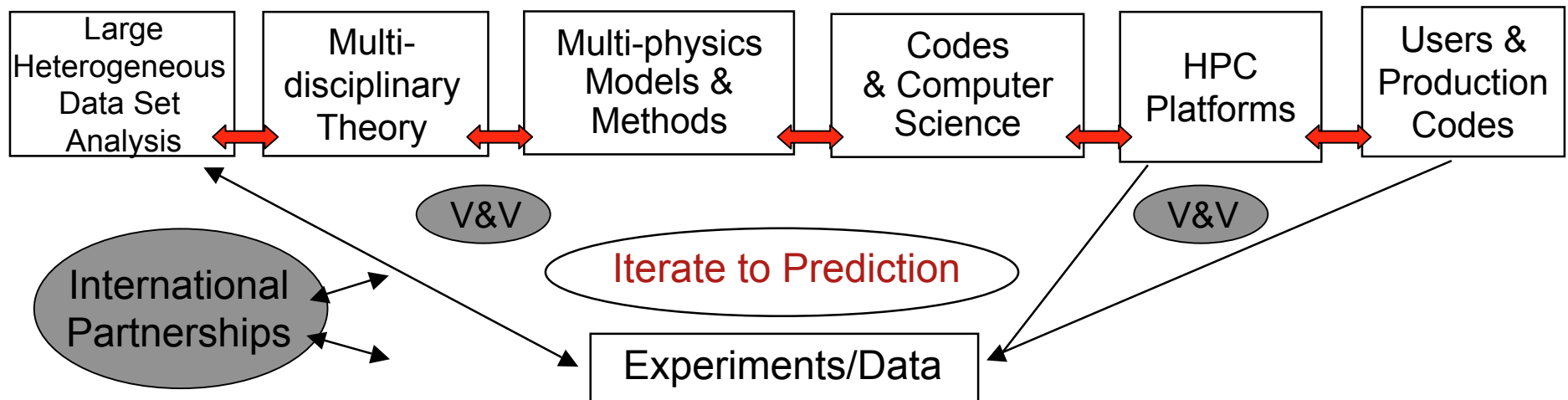
Ocean Vorticity Modeling



Soot Measurements

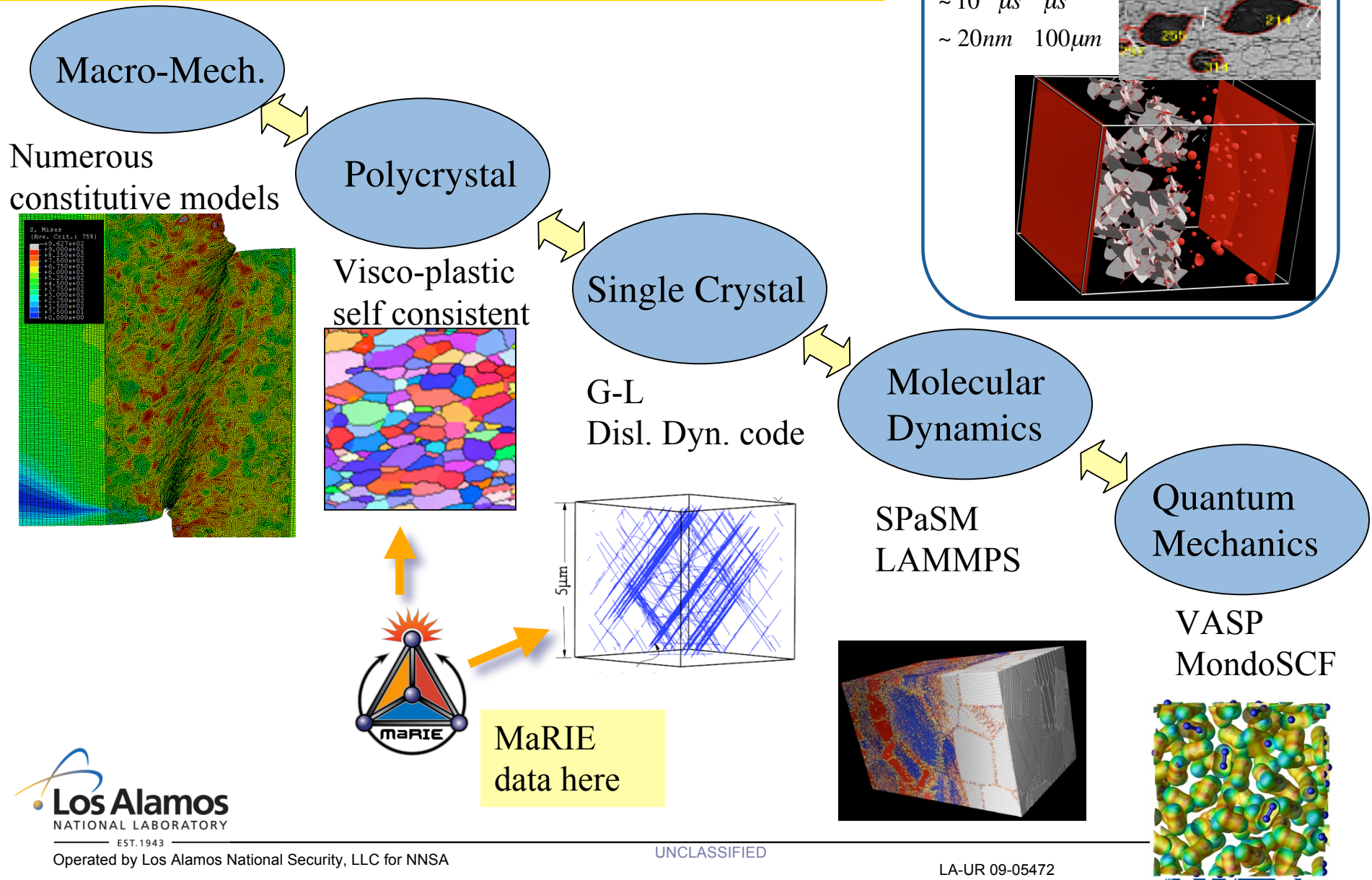
Theory, Modeling, Simulation and High-Performance Computing for Complex Systems

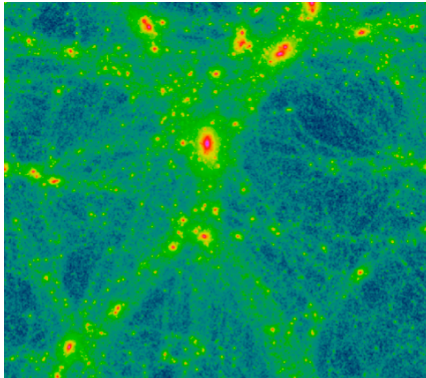
*... LANL's **Integration** Capability ... the heritage of 60+ years*



This integrated capability at scale is central to the huge national need for new generations of ideas, concepts, and methodologies to improve the fidelity, reliability, certainty, and usability of tools to guide and interpret experiments, and provide prediction and control for complex phenomena and systems.

Theory & models for simulations on HPC (petascale platforms for materials response)

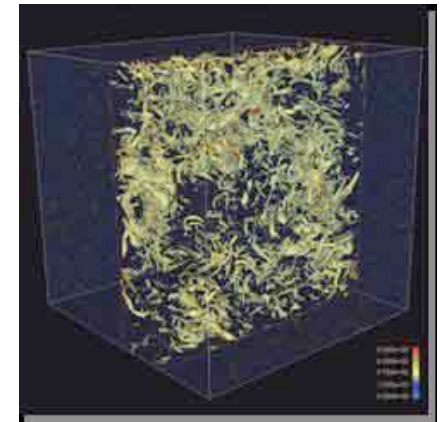




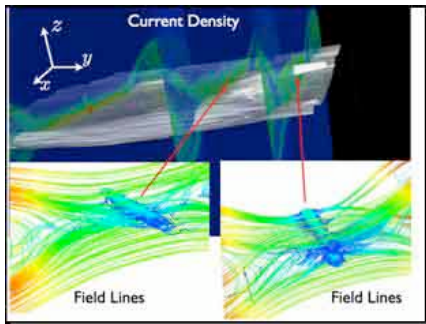
Cosmology: Filaments, Clusters, and Voids

“The Century of Complexity”
(Systems of connected functional scales;
Emergent properties)
Enabled by huge advances in Data,
Simulation, Nonlinear Science...

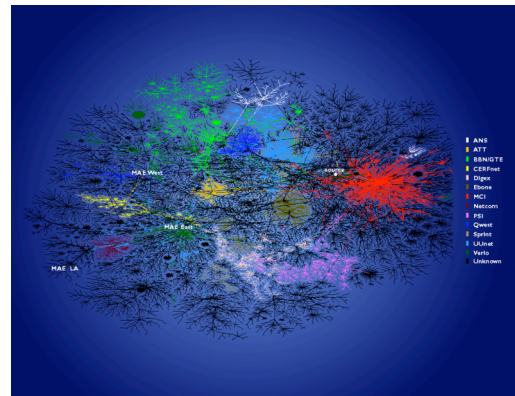
? Origins, Measures, Consequences ?



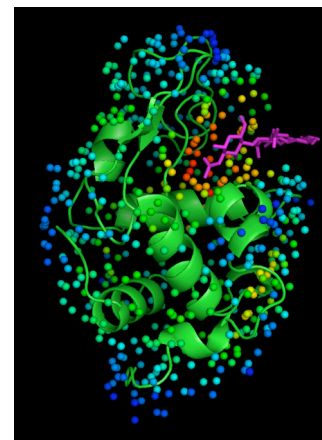
Fluid Turbulence



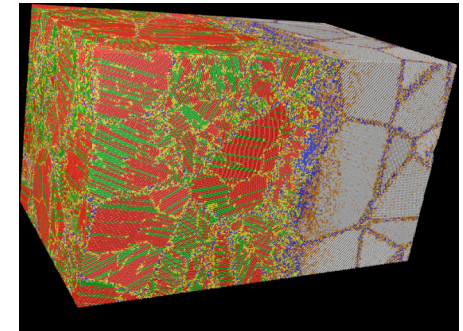
Magnetic Reconnection



Communication Networks



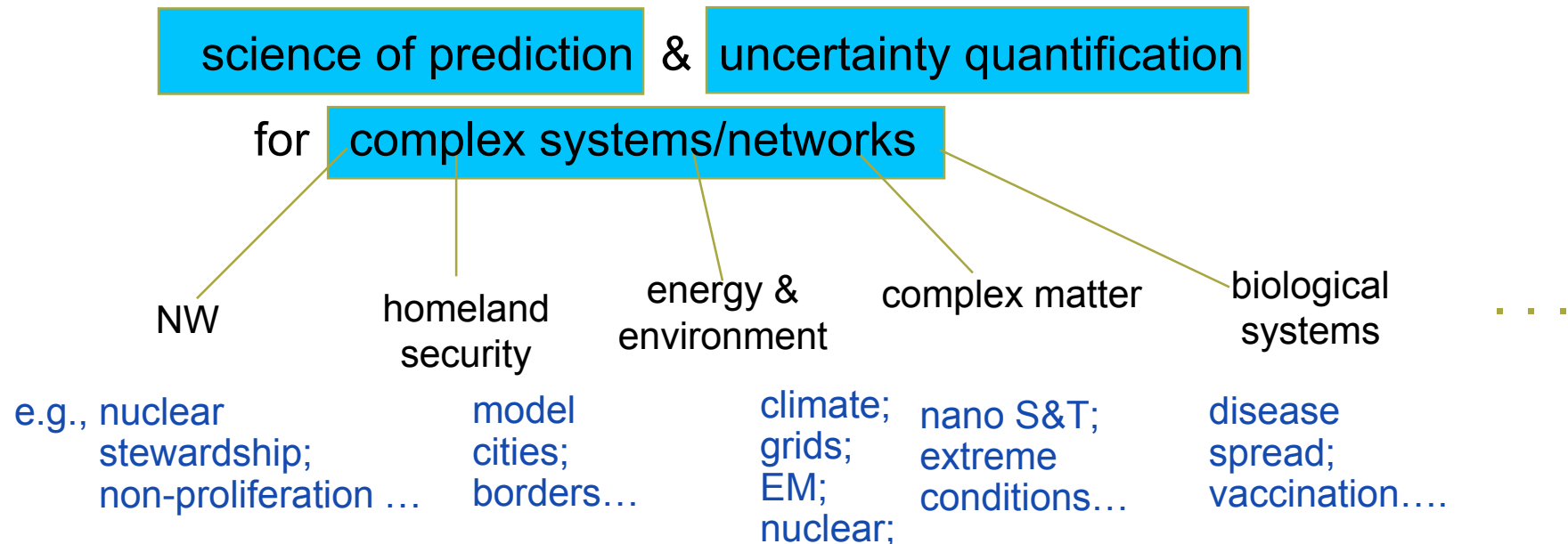
Protein Dynamics



Shocked Metals

The Promise and Challenge of Science (and Survival) in the 21st Century

- * Isolating complicated phenomena to “understand” them necessary, but not sufficient



- * Quantitative tools for decision makers/risk assessment
 - (coupled) socio, economic, humanities, physical sciences, ...
 - from observation and validation to prediction and control

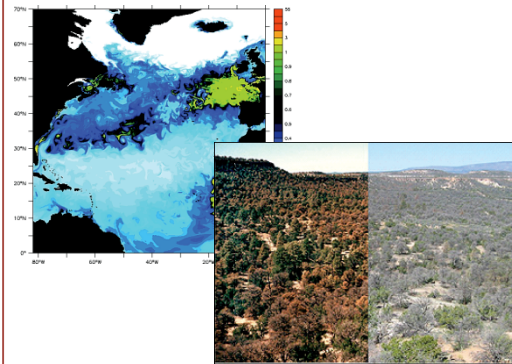
Energy-Climate Impacts Project (ECI) – Scientific Scope (Multi-Lab)

GHGIS – Measurements & Uncertainty Quantification



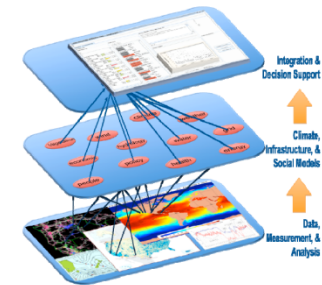
LANL ECI scientists contribute to the new GHGIS through estimating uncertainties, designing new instruments to measure GHGs, and using modeling to design the placement of new instruments.

Climate & Natural Systems Modeling



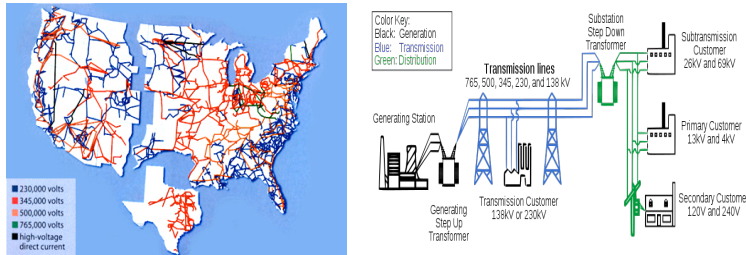
LANL ECI scientists participate in developing some of the most advanced climate models in the world: an ocean model, a sea ice model, physiology-based models for vegetation mortality, and a land ice model.

Social, Energy & Infrastructure Modeling for Climate Treaty support solutions



LANL ECI scientists can develop and apply Decision Support Systems to model the impacts of climate change and GHG emissions on regional and local scales and model its impacts on energy, social dynamics, and Infrastructure.

Smart Grid as a National Grand Challenge



R&D Problems for Smart Grids

A future grid, in which modern sensors, communication links, and computational power are used to improve efficiency, stability, and flexibility, has become known as the “smart grid.”

R&D Methodology: Road Map for Smart Grids

Our road map is driven by emerging technologies such as renewables, storage, and meters and accordingly specifies the technical challenges in *Grid Design*, *Grid Control* and *Grid Stability*.

All of the above require scientific advances in

- Analysis & Control
- Scalability/Reliability Mosaics
- State Estimation
- Data Aggregation & Assimilation
- Middleware for the Grid
- Modeling Consumer Response

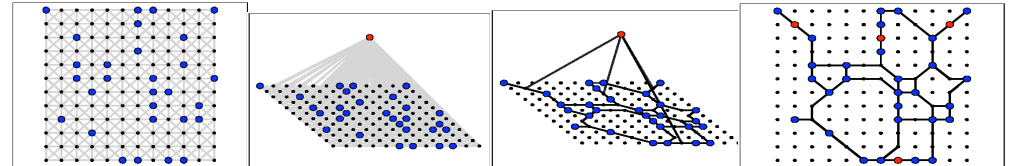


Operated by Los Alamos National Security, LLC for NNSA

Grid Designs



Generators – red dots
Loads – blue dots



original graph for
generation placement

“master generator”
connected to possible sites.

Resulting Sparse Network

$$\begin{aligned} \text{minimize} \quad & \text{Tr}(K(y)^{-1}W) + \sum_{\ell \in G} c_{\ell} \left(\frac{y_{\ell}}{\hat{y}_{\ell}} \right)^{\gamma} \\ \text{subject to} \quad & 0 \leq y_{\ell} \leq \hat{y}_{\ell} \text{ for all } \ell \in G \end{aligned}$$

Johnson, Chertkov '09
Network Optimization

NREL solution included

- Cost dispatch only
- Power flows highly approximate
- Unstable solutions
- Intermittency in Renewables not accounted

Toole, Fair, Berscheid,
Bent '09
go beyond NREL
“20% renewables
incorporated by 2030”

Impact to LANL, NNSA & the Nation

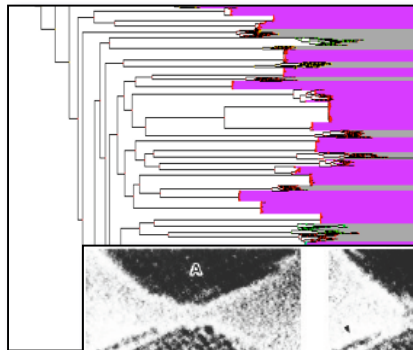
- Reduce consumer energy costs
- Promote energy independence
- Support national renewable penetration goals
- Address strategic problems at the intersection of energy, climate, and infrastructure
- Support LANL's Energy Security Center and LANL's Information Science and Technology Center

UNCLASSIFIED

LA-UR 09-05472

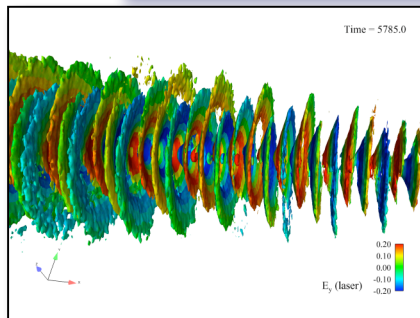
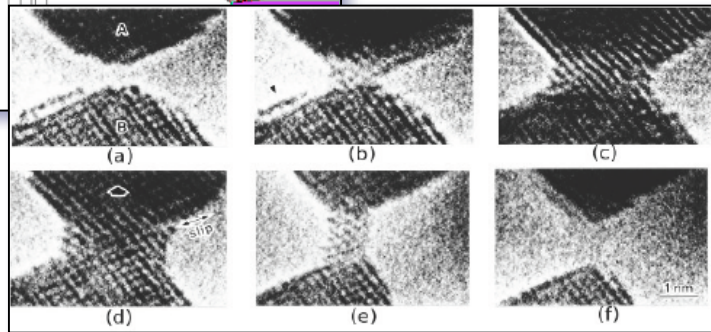


Los Alamos is committed to excellence in computer and computational sciences

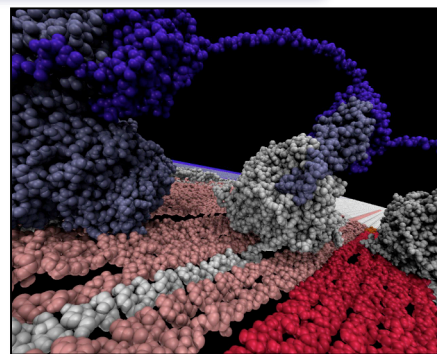


HIV epidemiology

Formation of nanomaterials



Laser plasma interactions



Breakdown of cellulose

■ Nuclear weapons program

- Support for enhanced Predictive/Control Capability

■ Open science

- Reliable and rich capability base for weapons
- Enabling new science and mission frontiers

■ Institutional computing

- Supporting scientific innovation and technology development
- Partnership with DOE-SC and ASC programs

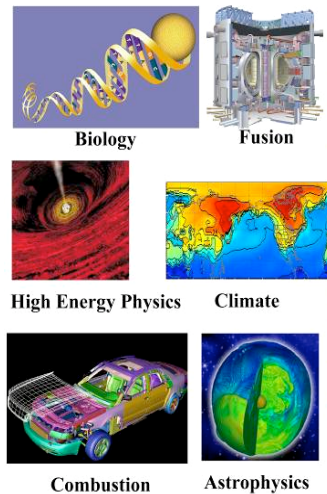
■ Investing in the future

- Centers/Institutes
- Exascale planning! (Joint DOE-SC/NNSA)
 - “Codesigning” applications, codes, architectures

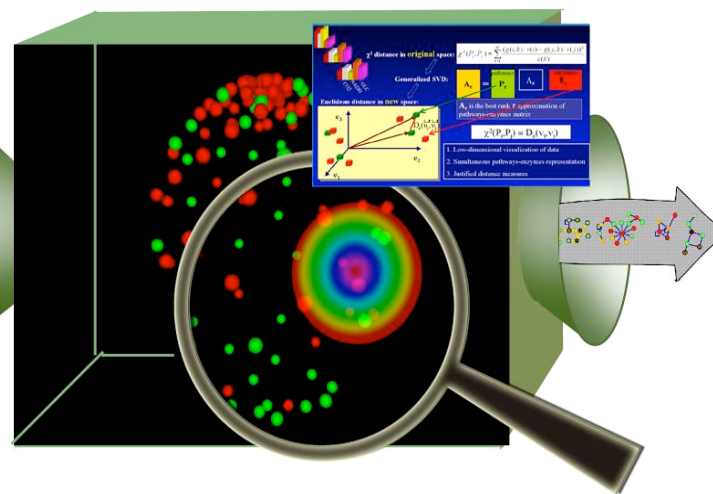
Information Science & Technology is the Infrastructure for Connecting the Dots in Science

Finding the Dots

Raw Scientific Data



Connecting the Dots



Understanding the Dots

Payoffs for the Nation



Sheer Volume of Data

Climate

Now: 20-40 Terabytes/year
5 years: 5-10 Petabytes/year

Fusion

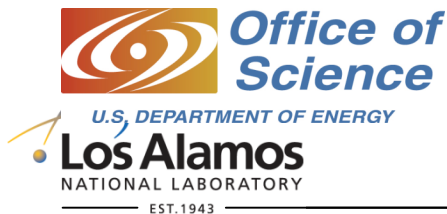
Now: 100 Megabytes/15 min
5 years: 1000 Megabytes/2 min

Advanced Mathematics and Algorithms

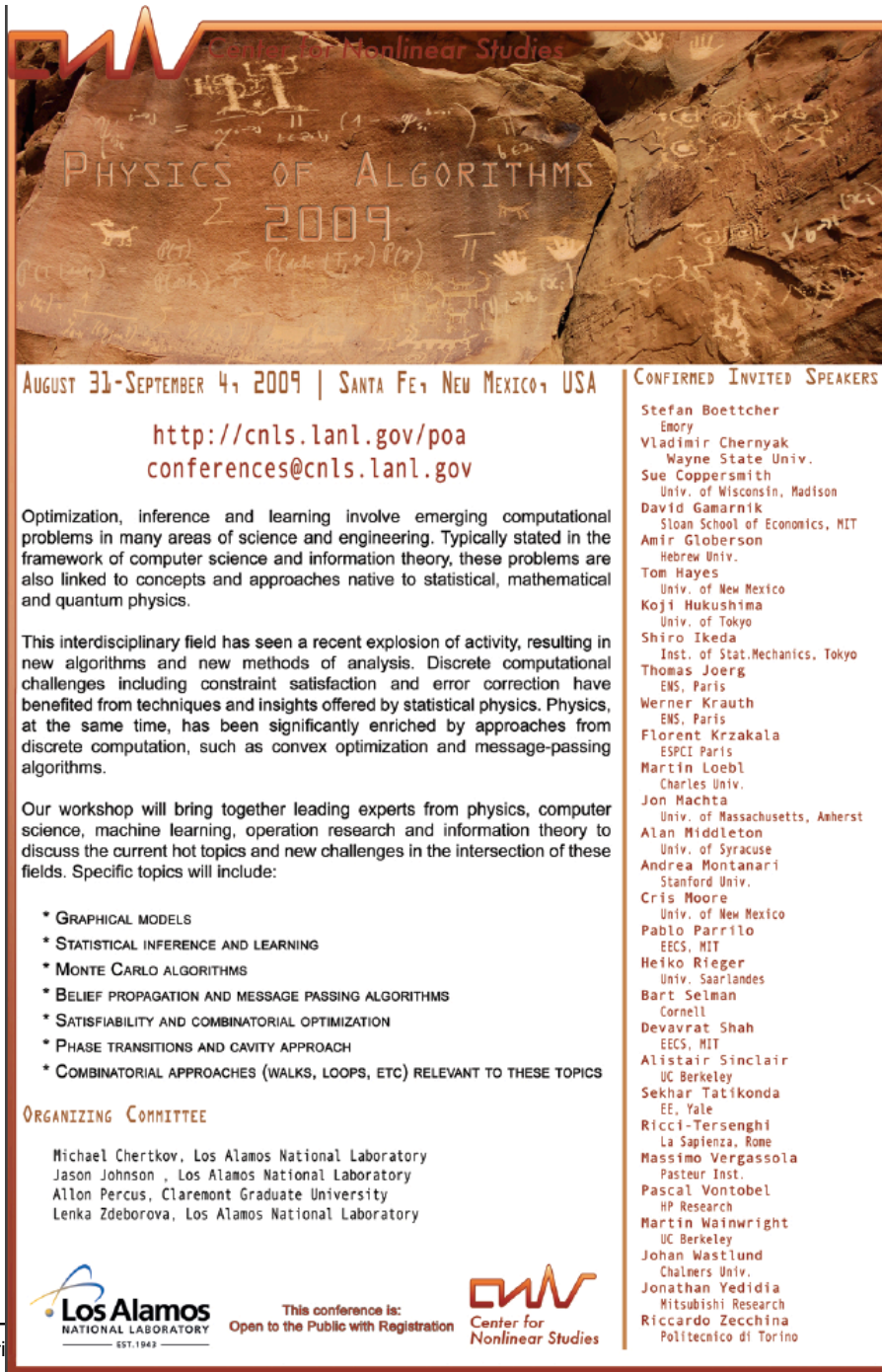
- Requires high-performance computing and advanced theory/modeling
- Huge dimensional space
- Combinatorial challenge
- Complicated by noisy data

Providing Predictive Understanding

- Produce hydrogen-based energy
- Stabilize carbon dioxide
- Clean and dispose toxic waste



c.f. Raymond L. Orbach, DOE Undersecretary for Science
2006 AAAS Annual Meeting



Center for Nonlinear Studies

PHYSICS OF ALGORITHMS 2009

AUGUST 31-SEPTEMBER 4, 2009 | SANTA FE, NEW MEXICO, USA

<http://cnls.lanl.gov/poa>
conferences@cnls.lanl.gov

Optimization, inference and learning involve emerging computational problems in many areas of science and engineering. Typically stated in the framework of computer science and information theory, these problems are also linked to concepts and approaches native to statistical, mathematical and quantum physics.

This interdisciplinary field has seen a recent explosion of activity, resulting in new algorithms and new methods of analysis. Discrete computational challenges including constraint satisfaction and error correction have benefited from techniques and insights offered by statistical physics. Physics, at the same time, has been significantly enriched by approaches from discrete computation, such as convex optimization and message-passing algorithms.

Our workshop will bring together leading experts from physics, computer science, machine learning, operation research and information theory to discuss the current hot topics and new challenges in the intersection of these fields. Specific topics will include:

- * GRAPHICAL MODELS
- * STATISTICAL INFERENCE AND LEARNING
- * MONTE CARLO ALGORITHMS
- * BELIEF PROPAGATION AND MESSAGE PASSING ALGORITHMS
- * SATISFIABILITY AND COMBINATORIAL OPTIMIZATION
- * PHASE TRANSITIONS AND CAVITY APPROACH
- * COMBINATORIAL APPROACHES (WALKS, LOOPS, ETC) RELEVANT TO THESE TOPICS

ORGANIZING COMMITTEE

Michael Chertkov, Los Alamos National Laboratory
Jason Johnson, Los Alamos National Laboratory
Allon Percus, Claremont Graduate University
Lenka Zdeborova, Los Alamos National Laboratory

CONFIRMED INVITED SPEAKERS

Stefan Boettcher
Emory

Vladimir Chernyak
Wayne State Univ.

Sue Coppersmith
Univ. of Wisconsin, Madison

David Gamarnik
Sloan School of Economics, MIT

Amir Globerson
Hebrew Univ.

Tom Hayes
Univ. of New Mexico

Koji Hukushima
Univ. of Tokyo

Shiro Ikeda
Inst. of Stat.Mechanics, Tokyo

Thomas Joerg
ENS, Paris

Werner Krauth
ENS, Paris

Florent Krzakala
ESPCI Paris

Martin Loebl
Charles Univ.

Jon Machta
Univ. of Massachusetts, Amherst

Alan Middleton
Univ. of Syracuse

Andrea Montanari
Stanford Univ.

Cris Moore
Univ. of New Mexico

Pablo Parrilo
EECS, MIT

Heiko Rieger
Univ. Saarlandes

Bart Selman
Cornell

Devavrat Shah
EECS, MIT

Alistair Sinclair
UC Berkeley

Sekhar Tatikonda
EE, Yale

Ricci-Tersenghi
La Sapienza, Rome

Massimo Vergassola
Pasteur Inst.

Pascal Vontobel
HP Research

Martin Wainwright
UC Berkeley

Johan Wästlund
Chalmers Univ.

Jonathan Yedidia
Mitsubishi Research

Riccardo Zecchina
Politecnico di Torino

Los Alamos NATIONAL LABORATORY
EST. 1943

This conference is:
Open to the Public with Registration

Center for Nonlinear Studies